a great tendency to cardiac weakness owing to the direct action of insufficient oxygen in the blood supplying the muscular walls of the heart.

This scanty and imperfect sketch may serve to show the very extensive field which is covered by the physiological work of the expedition, but, in addition, many valuable observations were made upon the symptoms, progress, and nature of mountain sickness. The cause of this complaint is, according to the authors, the deficiency of oxygen transport by the blood. The individual variations in the manifestation of the symptoms and the disappearance of the symptoms on habituation are considered to be due to the relative adequacy or inadequacy of the mechanisms by which the organism endeavours to protect itself against this oxygen deficiency. One such mechanism is the circulation flow, and if this is unable to bear the strain of increase, then nervous influences diminish the vascular area of the digestive organs in order to supply, so far as practicable, the higher nerve centres in the brain; in consequence of this anæmia, an extensive derangement of the digestive functions is produced which shows itself in the sickness and other symptoms that are the characteristic features of the trouble.

In conclusion, attention must be directed once again to the practical bearing of the Rothhorn experiments. These deal with the effects produced by moderately high altitudes, and to such altitudes thousands of men and women go every year, whilst the numerous sanatoria frequented by invalids are situated at these elevations. Moderate altitudes of less than 8000 feet appear, in consequence of the lessened atmospheric pressure, to benefit the whole organism in the following particulars. The tissue which produces the oxygen carriers of the blood is stimulated into greater activity, the oxidation of abnormal substances is increased, the heart's action is augmented, the respiratory muscular mechanism is brought into more energetic use, and, finally, that proteid assimilation which is so directly related to cell growth and cell restoration assumes the phase present in the young and growing animal. In consequence of all these changes, and particularly the last one, altitudes of from 4000 to 7000 feet must exercise a most beneficial and even rejuvenating influence. In the case of many invalids the effect will be to arm the body for its fight against such insidious foes as the tubercle bacillus and to hasten recovery in all cases of convalescence from bodily or mental prostration. Only those whose circulation is seriously impaired directly or indirectly by organic disease are debarred from the probability of such beneficial effects.

Experience has revealed to many the profound truth which is expressed in the beautiful and familiar words, "I will lift up mine eyes unto the hills, from whence cometh my help." In their monumental work Prof. Zuntz and his colleagues present physiological reasons for the assurance that whilst mountain scenery may arouse the imagination, mountain air will stimulate those organic functions which form the foundation for health of body and happiness of mind.

F. G.

A COMPREHENSIVE DYNAMICS FOR PHYSICISTS.

The Dynamics of Particles and of Rigid, Elastic, and Fluid Bodies. By Prof. Arthur Gordon Webster. Pp. xii+588. (Leipzig: B. G. Teubner, 1904.) Price 10 marks.

ATTENTION has been directed in more than one recent review to the tendency to over elaboration in the standard treatises to which an English reader would naturally turn for information on such branches of applied mathematics as the principle of least action, the potentials of ellipsoids, or the equations of motion of a perfect fluid. What has been said already must be said again, in order to make good the claims which Prof. Webster puts forward in his preface, and to prove that this book, written by an American and published in Germany, fills a distinct want.

That the student of physics should have to consult five volumes of Routh, three of Love, and a large work of Lamb is a state of affairs which could not very well be allowed to continue. It is true that these treatises afford an excellent preparation for the man who proposes to devote his whole lifetime to mathematical research, regardless of cost. But it is becoming more and more evident that the physicist must know something about the intricate mathematical machinery which has been so successfully employed to bring a large proportion of physical phenomena into one connected theory. We include under this category reversible phenomena. Whether the subject-matter of this book is called dynamics, or the study of quadratic forms, or the theory of geodesics in a hyperspace with special reference to particular definite applications makes no difference. The present reviewer may perhaps be allowed once more to state his conviction that irreversible energy transformations, whether statistical or non-statistical in character, cannot satisfactorily be accounted for as properties of quadratic forms except by the method of energy-accelerations, that is, by studying the *second*, and not the first, differential coefficients with respect to the time of the squares and products occurring in the energy function. But the omission of these phenomena leaves a great portion of modern physics which cannot be properly understood without some knowledge of a very extended and very advanced portion of applied mathematics.

In his preface—which, by the way, is so exhaustive as to leave a reviewer but little fresh to add—Prof. Webster states of the book that "It is obvious that it leads to no particular examinations, from which we in America are to a large extent fortunately free." Examples, as such, are therefore omitted, although most of the standard applications of general principles are included in the text; for instance, motion of a spherical pendulum, the brachistochrone and tautochrone under gravity, potentials of a disc and cylinder, form of a rotating liquid in a uniform field or under self-gravitation, torsion of elliptic and triangular prisms, and so forth. In connection with these applications an intentional feature is very con-

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spicuous, namely, the attempt, wherever practical, to illustrate the conclusions by diagrams or by appeal to experiment. Prof. Webster is a firm believer in both the analytical and the geometric method, and he rightly emphasises the importance of Lagrange's monumental work, in which there are no figures, but only algebraic equations. But *in the interpretation of results* the geometrical method is often the most fruitful, and it certainly appeals best to the reader who, like Prof. Webster, regards geometry as a physical subject. Possibly it is not so generally known as it ought to be that one important branch of dynamics, namely, uniplanar rigid dynamics, can be treated practically without the use of analysis by drawing diagrams for each problem, and inserting a force, Ma, at the centre of each mass, and a couple, $Mk^2d^2\theta/dt^2$, about that centre. Be this as it may, the curves illustrating the motions of tops, the compounding of oscillations, and similar problems convey much more meaning than a mere formula.

The book consists of three parts. The first deals with general principles and applications to systems of particles. It contains the principle of least action, the theory of free and forced oscillations for finite systems, and a short account of the theory of cyclic systems. The second deals with statics and dynamics of a rigid body. The third practically treats of continuous distributions of matter the dynamical properties of which are determined by partial differential equations with regard to the space-coordinates. By this we include attractions, theory of the potential, spherical and other harmonic analysis, elasticity, hydrostatics, hydrodynamics and sound.

Like every other book, this one has some good features and some defects. To take one or two small instances chosen at random; it is pointed out, rightly (p. 205), that the statement that forces applied to a rigid body are sliding vectors with five coordinates is not a property of forces, but of rigid bodies. On the other hand, it would be surely better to employ the word translation for rotation-couple on p. 209. Again, on p. 404, the expression for the potential of a distant body is not nearly so convenient as the ordinary form involving $A+B+C-3I$, which is not given.

Prof. Webster assumes a fair knowledge of the calculus, but not of differential equations or of higher analysis. It would, however, appear that a fair knowledge of the geometry of x, y, and z is needed; in evidence of this need, the equation

$$\cos^2\lambda+\cos^2\mu+\cos^2\nu=1$$

appears assumed on the second page. For anyone so equipped, Prof. Webster has "attempted to provide a treatise which would in not over a year's time offer to the student an amount of knowledge of Dynamics sufficient to prepare him for the study of Mathematical Physics in general."

But we are surely justified in examining what chances the English student of physics or engineering has of taking his place beside his American and German rivals in drawing upon this store of knowledge. The hopes that might have been raised a year or two ago as to prospective reforms in mathematical teaching will be sadly dispelled by a study of recent papers set in examinations for leaving school or matriculation. In these we find the old tendency to choke off the learner of an inquiring turn of mind, the old artificial questions on solving meaningless equations and simplifying meaningless expressions, mostly fractional, in short, everything best calculated to encourage mere mental gymnastics and to destroy all power of intelligently assimilating new ideas. The training required to produce a human examination-answering machine capable of working at matriculation level and of going no further would, if directed into a right channel, enable that same learner to differentiate and integrate rational algebraic functions, to calculate the areas of their graphs, and perhaps in the third year of a college course to read this book. G. H. B.

A NATURALIST'S PHILOSOPHY.

Essays on Evolution and Design. By the late Prof. John Young. Edited, with an analysis and an introduction, by William Boyd. Pp. xiii+248. (Glasgow: James Maclehose and Sons; London: Macmillan and Co., Ltd., 1905.) Price 6s.

MANY who knew the late Prof. John Young as a versatile thinker and keen critic will be interested in this posthumous volume which discloses his philosophy. To a wider audience the book will appeal by its vigorous criticism of mechanistic interpretations, its protest against theories of fortuity, and its confession of faith in a cosmic plan. The author seems to have felt acutely that the scientific formulations which attempt to give a genetic description of how things have come about fall very far short of being adequate, and that in any case they are never *explanations* which will satisfy the human spirit. Prof. Young sought to show that whether we consider the fundamental concepts of matter and force, the living organism, or the mind of man, we find that the naturalistic scheme is either guilty of *petitio principii* or of that "materialism" which attempts to give a false simplicity to the facts. The principle of continuity breaks down at every point, and our only alternative to giving up scientific explanation (as so many have done) is to fall back on the idea of design, and to make appeal to "the regulating influence of plan of some sort."

To many it will appear that the bulk of the book is an *argumentum ad ignorantiam*, and that many of the failures in scientific interpretation on which the author laid an incisive finger are only partial and temporary failures. Where he found insuperable difficulties, *e.g.* in the application of the selectionist theory, others find corroboration and encouragement. But it may serve a useful purpose to have vividly pointed out some of the difficulties involved in the origin of living organisms with individualities of their own, in the evolution of many important phenomena of animal structure and function, in the rise and progress of mental life, and in the emergence of the distinctively human "ought." If we under-

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